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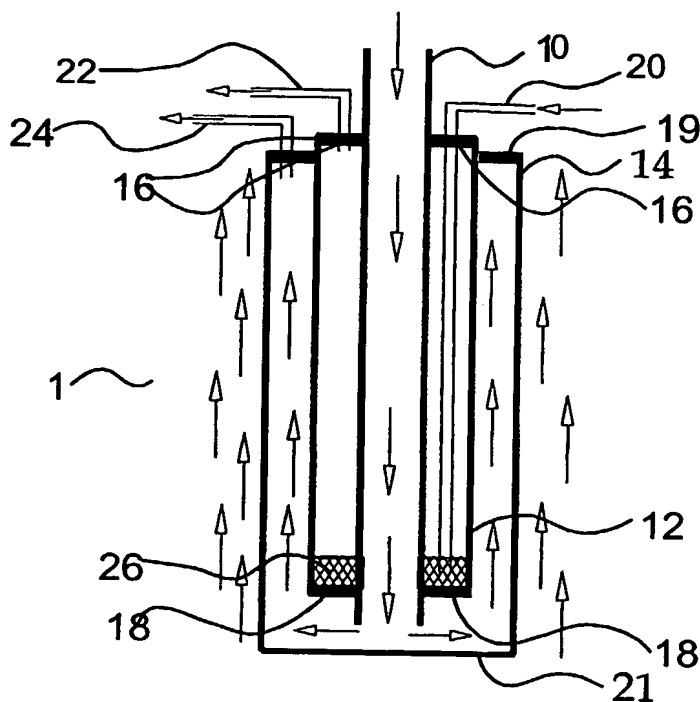
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**Published:**

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

[Continued on next page]

(54) Title: COMPACT SOLID OXIDE FUEL CELL STACK



(57) Abstract: A solid oxide fuel cell stack comprises a plurality of tubular solid oxide fuel cells each comprising concentric inner and outer electrode layers sandwiching a concentric electrolyte layer. The fuel cells extend in the same direction and are arranged in a cluster with at least one fuel cell having an electrolyte layer with a different composition and different maximum operating temperature than another fuel cell in the cluster. The fuel cell having the electrolyte layer with a higher maximum operating temperature is located closer to the core of the cluster than the fuel cell having the electrolyte layer with a lower maximum operating temperature.

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3 March 2005

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# INTERNATIONAL SEARCH REPORT

International Application No.

P 03/01992

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01M8/12 H01M8/24 H01M8/12 H01M8/24 H01M8/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data, COMPENDEX, INSPEC

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 458 477 B1 (HSU MICHAEL S) 1 October 2002 (2002-10-01) column 3, line 57 - line 64 column 4, line 19 - column 5, line 8 column 7, line 20 - line 23 column 8, line 41 - line 56 column 12, line 62 - column 14, line 54 figures 3,4 claims 28,29,68-70,114,115,142,143	1-17
X	WO 01/71841 A (US ENERGY ; MICHAEL A COBB & COMPANY (US)) 27 September 2001 (2001-09-27) the whole document	18-25
Y	----- -/--	26-37

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

5 January 2005

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# INTERNATIONAL SEARCH REPORT

International Application No

CA 03/01992

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 01/86030 A (ALBERTA RES COUNCIL ; SARKAR PARTHO (CA)) 15 November 2001 (2001-11-15) claims 17-22	26-37
P,A	WO 03/001624 A (PALL CORP) 3 January 2003 (2003-01-03) claims 20-26 paragraph '0256!	26-37
A	EP 0 320 087 A (WESTINGHOUSE ELECTRIC CORP) 14 June 1989 (1989-06-14) figures 1,2	18-25

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/CA 03/01992

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-17

the solid oxide fuel stacks of claims 1 to 17  
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2. claims: 18-25

the solid oxide fuel stack of claims 18 to 25  
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3. claims: 26-37

methods of manufacturing a solid oxide fuel cell elements  
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

CA 03/01992

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6458477	B1	01-10-2002	
		US 6083636 A	04-07-2000
		US 5976332 A	02-11-1999
		US 5693201 A	02-12-1997
		US 5501781 A	26-03-1996
		AT 246407 T	15-08-2003
		AU 764895 B2	04-09-2003
		AU 1335100 A	22-05-2000
		CA 2350098 A1	11-05-2000
		CN 1339181 T	06-03-2002
		DE 69910060 D1	04-09-2003
		DE 69910060 T2	15-04-2004
		EP 1127382 A1	29-08-2001
		JP 2002529893 T	10-09-2002
		RU 2227348 C2	20-04-2004
		TW 474043 B	21-01-2002
		WO 0026983 A1	11-05-2000
		US 2004091764 A1	13-05-2004
		AT 184425 T	15-09-1999
		AU 688568 B2	12-03-1998
		AU 3269795 A	07-03-1996
		AU 704873 B2	06-05-1999
		AU 6197398 A	18-06-1998
		BR 9509065 A	23-12-1997
		CA 2196764 A1	22-02-1996
		CA 2297610 A1	22-02-1996
		CN 1423034 A	11-06-2003
		CZ 9700358 A3	16-07-1997
		DE 69512075 D1	14-10-1999
		DE 69512075 T2	27-04-2000
		DK 776529 T3	03-04-2000
		EP 0776529 A1	04-06-1997
		ES 2136872 T3	01-12-1999
		GR 3031969 T3	31-03-2000
		HK 1014224 A1	05-05-2000
		HU 77148 A2	02-03-1998
		IL 115649 A	31-08-2000
		IL 125399 A	14-08-2002
		JP 11503860 T	30-03-1999
		JP 2000311698 A	07-11-2000
		KR 271096 B1	01-11-2000
		NO 970586 A	08-04-1997
		NZ 291537 A	28-01-1999
		NZ 332940 A	29-07-1999
		RO 116851 B1	29-06-2001
		US 2003012997 A1	16-01-2003
		WO 9605625 A2	22-02-1996
		US 6024859 A	15-02-2000
		US 5948221 A	07-09-1999
		PL 318546 A1	23-06-1997
WO 0171841	A	27-09-2001	
		US 6423436 B1	23-07-2002
		AU 1789801 A	03-10-2001
		CA 2385926 A1	27-09-2001
		EP 1254487 A2	06-11-2002
		JP 2003528439 T	24-09-2003
		WO 0171841 A2	27-09-2001
WO 0186030	A	15-11-2001	
		CA 2308092 A1	10-11-2001

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

CA 03/01992

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 0186030	A		AU 5997001 A	20-11-2001
			WO 0186030 A1	15-11-2001
			EP 1194615 A1	10-04-2002
			JP 2003532609 T	05-11-2003
			US 2003178307 A1	25-09-2003
			US 6607645 B1	19-08-2003
WO 03001624	A	03-01-2003	US 2002197520 A1	26-12-2002
			WO 03001624 A2	03-01-2003
EP 0320087	A	14-06-1989	US 4874678 A	17-10-1989
			CA 1318938 C	08-06-1993
			DE 3874498 D1	15-10-1992
			DE 3874498 T2	11-03-1993
			EP 0320087 A1	14-06-1989
			JP 1169878 A	05-07-1989
			JP 2947557 B2	13-09-1999
			NO 883432 A	12-06-1989